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Nurturing Industrial Revolution 4.0 Ready Graduates Through Sustainable Academic Programmes

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Abstract

Industrial Revolution 4.0 (IR 4.0) is characterized by a range of new technologies that are combining the physical, digital, and biological worlds that impact all discipline, industry, economy, and education. Universiti Malaysia Sarawak has responded appropriately to prepare both educators and students to thrive the future by rethinking and redesigning their current curriculum approach in academic programmes. This paper discusses on how Universiti Malaysia Sarawak nurture the IR4.0 ready graduates through robust academic programmes in two perspectives: (1) sustainability of academic programmes and (2) monitoring of High Impact Educational Practices (HIEPs) and Future Ready Curriculum (FRC) framework implementation. Sustainability of academic programmes are calculated based on four indicators: programme popularity, graduate on time, graduate employability, and merit of entry. HIEPs and FRC implementation in academic programmes are monitored based on their respective criteria via key performance indicator (KPI) internal audit. The academic programme sustainability index data for the student intake between 2014 and 2016 indicated that most programmes require strengthening strategies or curriculum modification in order to produce future ready graduates. Excellent percentage of HIEPs and FRC implementation in academic programmes were recorded in 2018 and 2023 (90-100%). In conclusion, Universiti Malaysia Sarawak strategic initiatives showed its strong commitment towards enhancement of academic programme for nurturing IR4.0 ready graduates.

Keywords: Industrial Revolution 4.0; Sustainable Academic Programme; Future Ready Graduate

INTRODUCTION

In the fast-paced scenario of the Industrial Revolution 4.0 (IR 4.0), Higher Education Institutes are confronted with the issue of ensuring that their graduates possess the capabilities required to flourish in the technologically dominated society (Seotsanyana, 2020). This will call for a paradigm shift in programmes of study, to make certain that such programmes are not only applicable but viable in the midst of incessant technology evolutions that demand a responsive and adaptable curricular development and pedagogical practices (Ahmad et al., 2022). It has become a priority to incorporate emerging technologies in order to prepare the future-ready students and educators to face the challenges of the IR 4.0 (Yusuf et al., 2020). By connecting learning outcomes with the demands of the present workforce, institutions of higher education can propel a generation capable of the future supported by

a robust generation that can create innovation and motivate its economic development (Azofeifa et al., 2024; Junaidah et al., 2020). Universities must be responsive and adopt an active role in serving the needs of the IR 4.0 by a complete reimagining of curriculum so that future graduates are adequately prepared to face the new world of work (Ahmad, 2019). Curricula must change continually to include advancing technology and interdisciplinarity, the requirement of abandoning old disciplinary lines in order to secure a deeper, more total appreciation of complicated systems and matters (Alenezi, 2023).

A primary objective of higher education is to impart the knowledge, technical competence, adaptability skill sets, and dynamic attributes students will need to gain employment and then succeed, flourish, and be leaders within the workplace with prospects for further continued success in addition to the support of society's workforce for tomorrow (Pandya et al., 2023). Experiential learning, including internships, industry projects, and simulations, must be incorporated into the curriculum to provide students with real-world experience and exposure to knowledge application in real-life situations (Dang et al., 2024). Educators must shift their pedagogical approaches, moving beyond the traditional lecture format to embrace active learning approaches, project-based activities, and collaborative work that promote critical thinking, problem-solving, and creativity (Surtikanti et al., 2020). Moreover, educators must prioritize incorporating into the curriculum the latest technological platforms and tools so that students can acquire the competency and adaptability required for the proper utilization and management of the technology of today (Coetzee et al., 2021). To do this, educators need to be able to incorporate new educational methods that enhance creativity, respond to the learning differences of students, and ultimately maximize learners' ability to learn (Mekacher, 2022).

The cultivation of essential soft skills, such as communication, teamwork, critical thinking, and emotional intelligence, is of paramount importance, forming a foundation in the creation of well-rounded and adaptable graduates prepared to flourish in the IR 4.0 environment. To equip students to effectively handle the dynamics of the modern workplace, these fundamental skills must be deliberately infused into the curriculum and their attainment rigorously tested through a variety of pedagogical strategies, including group projects, interactive discussions, and detailed case study analyses. Apart from that, the students need to be motivated towards a growth mindset, whereby they embrace challenges, persevere through obstacles, and view failures as opportunities to learn and grow (Marzuki et al., 2024). As contemporary evaluation paradigms emphasize the use of higher-order cognitive abilities, college courses should actively include critical thinking, creativity, problem-solving, and advanced digital literacy in the core learning outcomes, requiring courses to move away from memorization and towards the development of an understanding of concepts and learning higher-order skills (Latip & Hardinata, 2020; Xia et al., 2024).

Furthermore, academics programs must embrace digital literacy, which includes competencies such as computer literacy and digital fluency (Kivunja, 2014). Industry collaboration is required to ensure that academic programs remain relevant and contemporary to the demands of the workplace, and this can be implemented through partnerships with industry leaders, advisory boards, and guest lectures by industry experts, which provide students with beneficial exposure to recent trends and future skills requirements. In addition, universities must actively foster entrepreneurial mindset and equip students with competencies to create their own businesses and become drivers of economic growth. Technology use is not merely a path to the end of improved student engagement, but also as a platform for instructing fundamental digital literacy skills, thereby equipping students to navigate with ease and exploit the digital landscape permeating every sphere of modern life and work. By integrating technology into learning it facilitates a deeper understanding of subjects since it allows students to apply knowledge in various contexts (Ayas & Charles, 2024). The shift from passive receipt of information to active accessing of information reflects a fundamental transformation in education, enabling technology's potential to improve academic achievement and develop essential 21st-century competencies (Kalyani, 2024). In addition to the wealth of information available, the digital landscape fosters collaboration and communication among students, educators, and experts across the globe, enriching the educational experience and fostering a sense of interconnectedness. Also, the expansion of virtual classrooms, online learning platforms, and digital tools has democratized education, transcending geographical and socio-economic barriers, thereby enabling individuals from all walks of life to achieve their educational aspirations and unlock their full potential. Online learning is progressively not just seen as a substitute for conventional pedagogy, but as a paradigm shift that creates more active, personalized, and interesting learning environments, and hence enables a better conceptualization of difficult ideas and

the acquisition of critical thinking abilities (Alshehri, 2024). Digital transformation does not simply involve the adoption of new technologies but in creating a culture of innovation and lifelong learning required to negotiate the challenges of the modern world (Lešinskis et al., 2023). The omnipresent influence of digital technologies has catalyzed revolutionary changes in various facets of modern society, with education experiencing a paradigm shift in light of these advances (Haga, 2023).

Therefore, it is crucial for higher education to design academic programmes which prepare their graduates with future skills to thrive in the IR4.0 era. With that regards, Malaysia's Ministry of Higher Education (MoHE) has prepared the Malaysia Education Blueprint 2015-2025 that includes 10 shifts for continuous improvement in higher level education (MOHE, 2015). Academic programmes have undergone continuous quality improvement (CQI) process to ensure its relevance to the current and future needs of industry. However, the aspects and indicators of CQI in academic programmes must be clear and significant towards nurturing future graduates. It is the responsibility of higher education provider (HEP) to monitor the CQI process and set significant indicators for academic programmes to be sustainable in the IR4.0 era.

Universiti Malaysia Sarawak (UNIMAS) has responded appropriately to prepare its graduates with future skills and competencies to thrive in the IR4.0 era. Thus, this paper aims to (1) determine the sustainability index of UNIMAS academic programmes, and (2) assess the level of readiness of UNIMAS academic programmes in nurturing IR4.0 ready graduates through implementation of HIEPs and future-ready curriculum.

METHODOLOGY

Data collection as conducted by the Centre for Academic Development and Management (CADM), a one-stop centre for overseeing the academic development and management of all academic programmes in UNIMAS. The objectives of this analysis are to: (1) create a measurement method to see the sustainability of the academic programmes offered at UNIMAS, (2) take appropriate action /alternative action against less competitive academic programmes, and (3) to ensure that academic programmes are offered at quality and relevant levels to country and industry, viable, and responsive as well as have job opportunities based on current market demand and engagement with industry. Figure 1 shows the flowchart of determination of the sustainability index for UNIMAS academic programmes. There are four parameters which include the programme popularity, graduate on time, graduate employability, and merit of entry. These parameters were chosen based on the criteria given by MoHE that give impact to the sustainability of the programme. A number of 42 undergraduate programmes and 12 post-graduate programmes in UNIMAS were analysed based on the selected parameters data from 2016 to 2018. The summary of the sustainability indicator programme is shown in Table 1. The detail of the index programme band is set from 1-4 as depicted in Table 2. Upon completing the analysis, the university proposed and implemented new strategy to ensure the academic programme offered by UNIMAS is relevant and competitive.

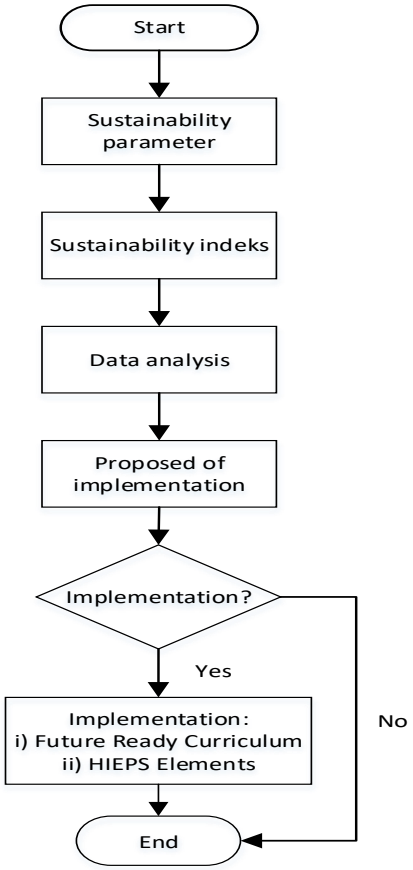

Figure 1 Flow chart of Sustainability data analysis of academic programme

Table 1 Sustainability indicator programme

Parameter	Band 1 Very High	2 High	3 Moderate	4 Low	5 Very low
Programme popularity (Percentage of student choosing the programme as first choice over the total number of students applying for the programme).	>80%	60%-79%	40%-59%	20-39%	<20%
Graduate on Time (GOT) (Percentage of student who graduated on time in the programme)	>80%	60%-79%	40%-59%	20-39%	<20%
Graduate employability (GE) (Percentage of graduate employability after 6 months of student graduation)	>80%	60%-79%	40%-59%	20-39%	<20%
Merit of entry (Cumulative Grade Points Average (CGPA) of students upon entry to the programme)	4.00-3.71	3.31-3.70	3.00-3.30	2.51-2.99	0-2.50

Table 2 Action required on academic programme based on the overall sustainability index band

Band	Action Required on Academic Programme
1	Maintain as it is
2	Strengthen the programme
3	Modification of the programme
4	Rebranding of the programme
5	Programme to consider 'on hold' status

Data Collection

Data collection for obtaining the number of academic programmes implementing Service Learning/Community and four others HIEPS was conducted on 42 undergraduate programmes and 12 post-graduate programmes in UNIMAS in 2018-2023. The implementation of HIEPs in UNIMAS academic programmes were compulsory for academic programmes and measured through the strategic focus: Excellence in Education and Training - key performance indicator (KPI) achievement. Each programme was required to implement Service/Community Based Learning as compulsory HIEPs element, together with another 4 elements.

Table 3 KPI 1 - Number of Academic Programmes Implementing Service Learning/Community Based Learning and Four (4) Other HIEPS

No	HIEPs Element	Marks
1	Compulsory HIEPs Element Service / Community Based Learning (SBL)	20%
2	GROUP A: Select any 3 of the following HIEPS Elements (20% each). Number of courses = 3 • Teaching-Learning Activities (10%) • Assessment Rubrics (10%) HIEPS Elements: o First Year Seminar and Experiences (FYS) o Interdisciplinary Approach to Assessment (ID) o Diversity/Global Learning (DGL) o Capstone Courses and Project (CAP)	40%
3	GROUP B: Select any 3 of the following HIEPS Elements (20% each). Number of courses = 3 • Teaching-Learning Activities (10%) • Assessment Rubrics (10%) HIEPS Elements: o Intensive Academic Writing (IAW) o Collaborative Assignments and Projects (CAS) o Empirical Research (ER) o Internship (IN)	40%
	TOTAL	100%

Table 4 KPI 2 - Number of Academic Programmes Implementing Future Ready Curriculum (Undergraduate / Postgraduate)

Element	Sub-Elements	Description
Element 1 Fluid and Organic Curriculum Structure	• Convergence of • Disciplines (multi /inter /transdisciplinary) • Flexible & non-conventional • Industry Partnership • Global	Select any of the following options: Option 1: Element 1 The indicator will be evaluated based on the following: (i) Curriculum Structure (New/Revised) – (from 30% target in 2020 (ii) Evidence of implementation – 50%
Element 2 Transformative Learning and Teaching Delivery	• 21st Century Pedagogies (Heutagogy/Paragogy/Cybergogy) • Immersive Experiential Learning • Futuristic Learning Spaces and Technologies	Select any of the following options: Option 2: Element 2 AND/OR Element 3 The indicator will be evaluated based on the following: (i) 50% of the core courses must consist of Element 2 AND/OR Element 3 with evidence of implementation. (ii) The calculation will be based on the number of courses assigned under each element
Element 3 Alternative Assessment	• Authentic • Performance-Based • Personalized • Integrated • Contemporary • Real-Time • Challenged-Based • Profiling	

FINDINGS AND DISCUSSION

Sustainability Index of academic programmes in UNIMAS

Figure 2 shows the sustainability index band of undergraduate (U) and postgraduate (P) academic programmes in UNIMAS from 2014-2016. A number of post-graduate programmes falls under Band 2 and 4 between year 2014 to 2016. Band 2 programmes are required to undergo strengthening activities, while Band 4 programmes are required to undergo modification. Findings also have shown that from 2014 until 2016, all programmes in UNIMAS requires change – whether to strengthen, modify, and rebrand the programme. However, none of the programme were considered to be put 'on hold'. The number of programmes has been increased to strengthen the programme and have been modified from 2014 to 2016. Meanwhile, the number of programmes that have been going through rebranding were decreasing from 2014 to 2016.

The proposed action for both undergraduate and postgraduate programmes of different sustainability index bands are summarised in Table 5. Programmes which require to be strengthened (Band 2) were advised to add value to programme through optional professional certifications for reskilling and upskilling their students. For example, Bachelor of Aquatic Science and Management programme could offer a scuba diving certification programme, while Bachelor of Economics could offer a big data analytics certification programme to their students. The value adding process is expected to not only improve the programme's reputation, but also to prepare the graduates for job creation.

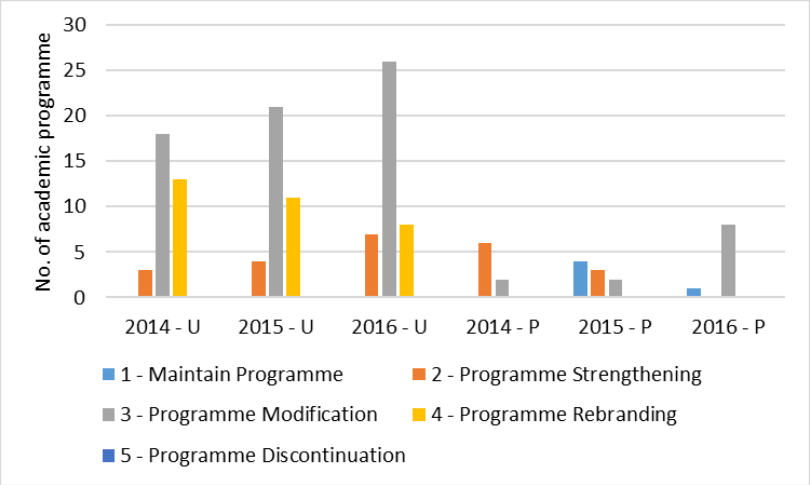

Figure 2 Sustainability index band of undergraduate (U) and postgraduate (P) academic programmes in UNIMAS from 2014-2016.

Table 5 Summary of proposed action for Undergraduate and Postgraduate programme of different sustainability index bands

Index	Proposed Action
2 – Programme Strengthening	The programme is required to add value to programme and improve the programme's reputation.
3 - Programme Modification	The programme is required to conduct major curriculum review on the learning unit, teaching and learning delivery strategy, and assessment.
4 - Programme Rebranding	Rebranding of programme involves new curriculum design and programme structure. (Examples: double degree, dual degree, Major Minor, 2u2i dan TVET programme).
5 – Programme On Hold	Programme on hold should not be taking new student intake during discontinuation period. The programme should carry on running with the current active students. Programme may decide to take new intake after curriculum review or proceed with freezing of programme once the on-hold period ends.

Programmes which require modification (Band 3) must conduct major curriculum review on the learning unit, teaching and learning delivery strategy, and assessment. Programme adaptation via curriculum review must be made to meet current and future needs. Programme has been recommended to infuse alternative assessment of the 21st century. Though the common traditional assessment has been perceived as good-enough proxies of academic skill, we are still in need of assessment that measure educational outcomes that are more pertinent and critical such as problem solving, critical thinking, collaboration, and creativity. For example, assignment can be designed in such a way that students can receive a better awareness of the current realities in their field. They should be given opportunities to work in diverse in-person and virtual project teams, and disciplines (Harrison, 2017).

One of the key indicators of a good higher education is the capability to facilitate different types of student's learning styles that includes acquiring professional skills, and skills of application, such as critical reflection, problem solving, conceptualizing, collaboration, civic and global learning, and reasoning (Berkeley Center for Teaching and Learning, 2018). Therefore, alternative assessment should be diversified so the skills of the students become more explicit.

Programmes with Band 4 are required to undergo rebranding process. Rebranding of programme involves new curriculum design and programme structure. Rebranding requires transformation of the conventional academic programmes into one of the following programme design/structures: double degree, dual degree, Major Minor, 2u2i, dan TVET programme. The

implications of the work process include new accreditation application and/or major curriculum review. For instance, the programme can establish a strategic partnership with a related industry partner using work-based learning (WBL) module for industrial training placement.

However, rebranding of programme through design/structure customization dictates current and future needs of graduates, industries, and communities. The rebranded programme is expected to attract more students and build a network of partnerships with stakeholders. Different stakeholders mainly the industry play a huge role in shaping the future of higher education sector. They provide key insights into the current and future demands of the market force and helps ensure curriculum-relevance.

Programmes with Band 5 are advised to consider to be put on hold. Programme on hold should not be taking new student intake during discontinuation period. Instead, the programme should carry on running with the current active students. Once all students have graduated, the on-hold period will end and programme may decide to take new intake after curriculum review or proceed with freezing of the programme. The on-hold status on programmes will lead to a decrease in university's number of students, reduced lecturer's teaching load, and no fee collection by the university. The programme will need to submit notification to Malaysian Qualification Agency (MQA) / MOHE regarding the programme status and the formation of a new/revised academic programme to replace the programme on hold.

HIEPs and Future Ready Curriculum Implementation Sustainability Index of academic programmes in UNIMAS

Based on the overall results of programme index band, UNIMAS academic programmes were demanded to make changes and transformation to prepare its graduates with new skills and competencies. While there are many challenges to be faced by higher education, it has become imperative to be prepared, and it is crucial to ensure the graduates remain relevant and able to thrive in the digital era.

"Nurturing Future Graduates" initiatives have been set as UNIMAS way forward to transformative education. The main focus of "Nurturing Future Graduates" are the academic rigor, experiential learning, and real-world relevance. The main aim is to provide UNIMAS graduates with strong employment prospects and skills of tomorrow. It is hoped that through re-evaluation and redesign of academic programmes, UNIMAS graduates will become resilient, adaptable, and optimistic in facing the ever-changing demands and challenges of the future, equipped with the necessary skills, knowledge, and mindset to drive innovation, contribute meaningfully to society, and thrive in a globalized world.

Thus, the two KPIs set under strategic focus 'Excellence in Education and Training' are crucial in catalysing the continual improvement of all academic programmes. KPI 1 – HIEPs implementation and KPI 2 – Future Ready Curriculum reveals Faculty initiatives and achievements in transforming academic programmes toward IR4.0. HIEPs has been implemented in UNIMAS undergraduate programmes since 2018 until 2023 (Figure 3). The achievement for HIEPs implementation in academic programmes were higher in 2020-2023 compared to 2018-2019. The overall achievement for this KPI 1 is 100% number of programmes that implementing Service Learning/ Community and four others HIEPS.

The number of academic programmes implementing future ready curriculum for undergraduate and postgraduate programme is depicted in Figure 4 and Figure 5, respectively. The implementation of future ready curriculum for all undergraduate and postgraduate programmes in has been monitored since 2018 until recently, 2023. The graph presents a comparison between the number of undergraduate programmes UNIMAS aimed to offer and what was actually achieved from 2018 to 2023. Over this six-year period, the target remained steady at 45 programmes until 2021, before gradually increasing to 47 in 2022 and 48 in 2023. On the other hand, the actual number of programmes achieved varied more noticeably. In 2018, the figure stood at just 34, falling well short of the target. A year later, however, there was a significant improvement, with 43 programmes offered—almost reaching the target. From 2020 to 2022, progress appeared to level off, with the achieved numbers hovering between 40 and 41. Encouragingly, 2023 saw a renewed increase, with 44 programmes achieved, bringing the university closer to its goal. These trends reflect the university's continuous efforts to expand and improve its academic offerings, even in the face of potential setbacks such as policy changes or the broader impact of the COVID-19 pandemic. The recent upward movement suggests that those efforts are paying off,

pointing to better planning and execution. Overall, the data highlights UNIMAS's ongoing commitment to providing a diverse and accessible academic environment aligned with its vision for the future.

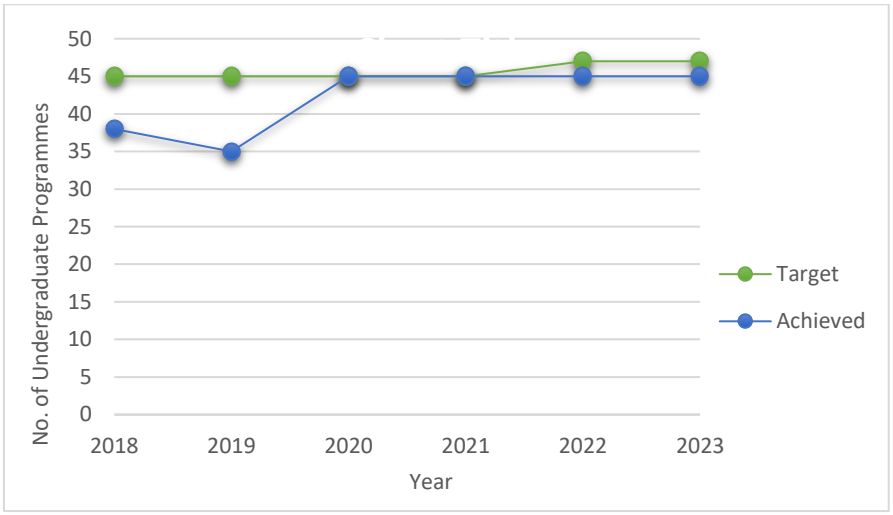

Figure 3 Number of Academic Programmes Implementing Service Learning/Community Based Learning and Four (4) Other HIEPS

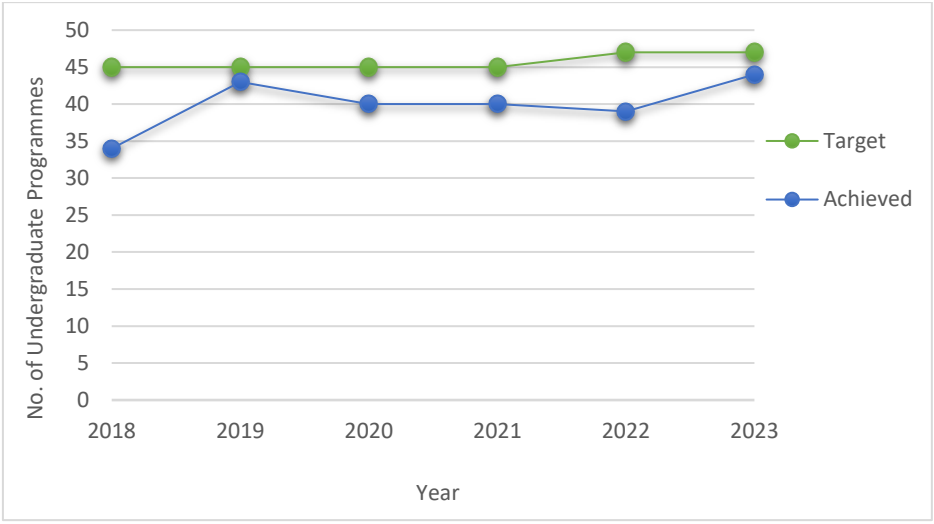

Figure 4 Number of Academic Programme Implementing Future Ready Curriculum for Undergraduate programme from 2018 until 2023

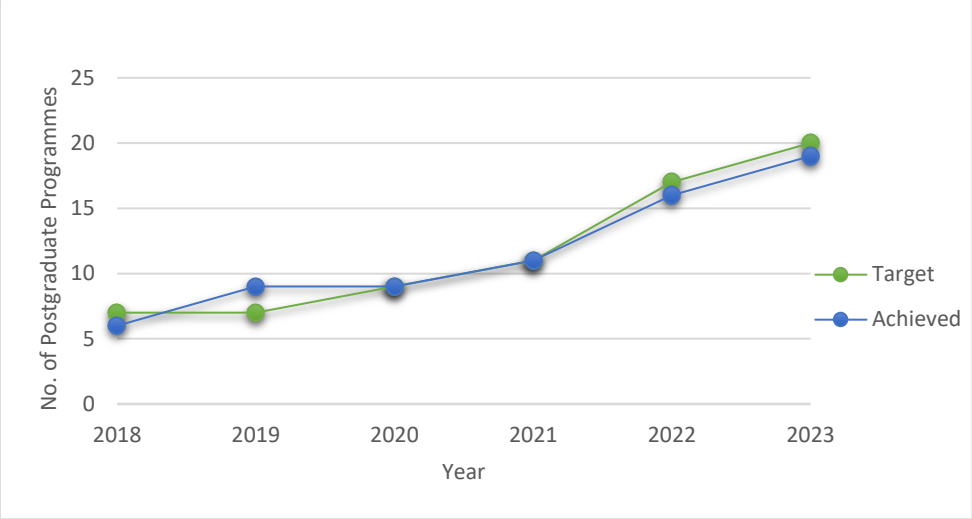

Figure 5 Number of Academic Programme Implementing Future Ready Curriculum for postgraduate programme from 2018 until 2023

With regards to future ready curriculum, Malaysian Education Blueprint 2015-2025 (Higher Education) has highlighted on industry-academia collaboration. There is a need to take collaboration between universities and the industry to the next level by participating in the curriculum design and delivery through partnership models such as apprenticeships, hands-on training, and specialised employer training programmes. Thus, UNIMAS is embarking on the 2u2i programme as part of the effort to create future-ready graduates. One successful programme involved in the 2u2i initiative is the Bachelor of Science in Agrotechnology, offered in the 2022/2023 academic session. The 2u2i stands for two years in university and two years in industry. It is a work-based learning programme in which students spend two years in the university to gain knowledge; and two years of hands-on practices in the industry.

By infusing industry-based skills into education, UNIMAS ensures its students to gain the practical know-how to match theories and holistic view on matters. Thus, UNIMAS graduates will stand out among all graduates in job market and job creation. Collaboration with the industry will allow UNIMAS students to be exposed to real case studies and latest industry insight, attend lectures, and get training assistance for educational purposes. Thus, industries can help shape the curriculum to enable graduates to fully understand the talents that they are looking for. For students, our future graduates, mismatch of skills required by the industry have always been the root of unemployment, hence there is a need for the academia-industry linkages through academic engagement via curriculum design, teaching and learning and internships.

UNIMAS should also benefit from the Service-Based Learning and incorporate more of this SBL model into its academic programmes. It provides the students with experiential learning pedagogy that integrates meaningful community service with academic study and reflections to enrich students' learning experience. SBL model has become a trending teaching and learning method in Malaysia public universities. Among the methods that have been practiced through SBL in Malaysia were problem-based learning, project-based learning, community case study, discipline-based project, and capstone project. According to Mamat et al. (2019), students participating in SBL model have obtained positive impacts which include the increase of soft skills and enhancement of values and ethics. Some the main takeaways inferred from this study that need to be addressed were:

i. Adjusting the way in which students learn (through more diversified teaching and learning strategy and alternative assessments)
ii. Transforming curriculum (through developing more creative and attractive degree programmes)
iii. Responding to student demands since the student market is becoming more increasingly competitive (such as offering a fast-track degree program and utilizing data analytics to assure students graduate-on-time (GOT) and to provide earlier academic intervention)

UNIMAS foresees that they will be able to attract students to their institution and meet their demanding needs. Programme curriculum innovation and thoroughly understanding students' demands and needs will be a huge factor in the future success of UNIMAS academic programmes.

CONCLUSION

The academic programme sustainability index data for student intake 2014-2016 indicated that most programmes require strengthening strategies or curriculum modification in order to produce future ready graduates. On a different note, excellent percentage of HIEPs and FRC implementation in academic programmes were recorded for 2018 and 2023 (90-100%). In conclusion, UNIMAS strategic initiatives showed its strong commitment towards enhancement of the academic programme for nurturing IR4.0 ready graduates.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

(Rohana Sapawi): Conceptualization, Original draft preparation. **(Rafeah Wahi)**: Data curation, Writing- Original draft preparation. **(Azzahrah Anuar):** Visualization, Review. **(Shanti Faridah Salleh):** Review, Editing. **(Maya Asyikin Mohamad Arif):** Data Curation, Editing. **(Nur Tahirah Razali):** Data Curation and Editing. **(Asrani Lit):** Reviewing, Editing. **(Nazreen Junaidi):** Reviewing, Editing. **(Sharifah Masniah Wan Masra):** Reviewing, Editing. **(Nordiana Rajaee):** Reviewing, Editing. **(Maimun Huja Husin):** Reviewing, Editing.

DECLARATION OF GENERATIVE AI

During the preparation of this work, the author(s) used [JENNI AI] to enhance the clarity of the writing. After using the [JENNI AI], the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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